UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/797,220	03/10/2004	Alan B. Duell	HES 2003-IP-009653U1	4106

29920 7590 01/25/2007

JOHN W. WUSTENBERG
P.O. BOX 1431
DUNCAN, OK 73536

EXAMINER	
COOLEY, CHARLES E	
ART UNIT	**PAPER NUMBER**
1723	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/25/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/797,220	DUELL ET AL.	
	Examiner	Art Unit	
	Charles E. Cooley	1723	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 October 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-44* is/are pending in the application.

4a) Of the above claim(s) *17 and 32-44* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16 and 18-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-44* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 March 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

NON-FINAL OFFICE ACTION

Election/Restriction Requirement

1. Claims 33-44 remain withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 15 MAY 2006. Applicant remarks claims 33-4 have been cancelled, yet the response filed 11 OCT 2006 lacks a listing of claims or any explicit directions to cancel these claims.

2. Applicant's election of Species A with traverse in the reply filed on 15 MAY 2006 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the species requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)). Claims 17 and 32 are thereby withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected species.

Drawings

3. The drawings are objected to because suitable descriptive and concise legends should be provided to label the depicted elements of the invention such as the water concentration sensor 48 in Figs. 1 and 3 and the densimeter in Fig. 3 for understanding of the drawings (37 CFR 1.84(o)). See the cited patent to Allen '239 for a suggested format (note the manner in which boxes 38. 84, 86, 102 have descriptive text therein). The blank boxes seen in the Figures originally filed in this application are virtually useless for image searching purposes.

INFORMATION ON HOW TO EFFECT DRAWING CHANGES

Replacement Drawing Sheets

Drawing changes must be made by presenting replacement figures which incorporate the desired changes and which comply with 37 CFR 1.84. An explanation of the changes made must be presented either in the drawing amendments, or remarks, section of the amendment. Any replacement drawing sheet must be identified in the top margin as "Replacement Sheet" (37 CFR 1.121(d)) and include all of the figures appearing on the immediate prior version of the sheet, even though only one figure may be amended. The figure or figure number of the amended drawing(s) must not be labeled as "amended." If the changes to the drawing figure(s) are not accepted by the examiner, applicant will be notified of any required corrective action in the next Office action. No further drawing submission will be required, unless applicant is notified.

Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin.

Annotated Drawing Sheets

A marked-up copy of any amended drawing figure, including annotations indicating the changes made, may be submitted or required by the examiner. The annotated drawing sheets must be clearly labeled as "Annotated Marked-up Drawings" and accompany the replacement sheets.

Timing of Corrections

Applicant is required to submit acceptable corrected drawings within the time period set in the Office action. See 37 CFR 1.85(a). Failure to take corrective action within the set period will result in ABANDONMENT of the application.

If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings MUST be filed within the THREE MONTH shortened statutory period set for reply in the "Notice of Allowability." Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136 for filing the corrected drawings after the mailing of a Notice of Allowability.

Specification

4. The abstract is acceptable.

5. The title is acceptable.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claims 1-3 are rejected under 35 U.S.C. 102(b) as being anticipated by DE 1921681.

DE 1921681 discloses a system for preparing a mixture of water and at least one non-aqueous material, comprising: a mixing zone 6; means 4, 8 for injecting water into the mixing zone; means for injecting the at least one non-aqueous material into the mixing zone (the inclined feed conveyor means seen on the right side of the Figure); and a sensor 1 disposed within the mixing zone that measures the concentration of water in the mixture; wherein the mixing zone comprises a mixing tub 6; wherein the sensor 1 is disposed within the mixing tub as seen in the Figure.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made..

9. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claims 1, 2, 4-16, and 18-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Allen (US 5,114,239) in view of DE 1921681 <u>or</u> Wang et al. (US 6,169,407).

Allen (US 5,114,239) discloses the recited system substantially as claimed including an apparatus for producing a mixture. The mixture includes a first substance and a second substance, and it can include additional substances. In a preferred embodiment the mixture is produced so that it has a desired density. In a preferred embodiment, the apparatus and method are used for producing an averaged mixture to be pumped into a well. The apparatus mixes dry cement and water at a well site to produce a cement slurry having a desired density for pumping downhole; however, it is the apparatus of the present invention has broader utility beyond these specific substances and this specific environment.

Referring to FIG. 1, a preferred embodiment of the apparatus of the present invention includes containment means 2 for containing a body of a first averaged

mixture. The apparatus also includes containment means 4 for containing a body of a second averaged mixture which includes a portion of the first averaged mixture received from the containment means 2. Connected to the containment means 2 is inlet means 6 for producing initial mixtures including at least two substances and inputting the initial mixtures into the containment means 2 so that the first averaged mixture is produced in the containment means 2. Thus, the first averaged mixture includes mixture received from the inlet means 6.

The apparatus further comprises means 8 for selectably directing a portion of the first averaged mixture from the containment means 2 into the containment means 4 for producing the second averaged mixture within the containment means 4. The apparatus also comprises recirculation means 10 for recirculating at least a portion of each of the first averaged mixture and the second averaged mixture back to the inlet means 6 for mixing with initial mixtures of the inlet means 6. Responsive to flows through the recirculation means 10 is a control means 12 of the apparatus. The control means 12 controls the inlet means 6 to produce desired initial mixtures from which a desired second averaged mixture can be obtained in the containment means 4. In a preferred embodiment illustrated in FIGS. 2 and 3, the foregoing elements are assembled and mounted on a suitable vehicle 14, such as a trailer which is transportable to a well site. The vehicle 14 is a conventional type adapted for the specific use for which it is intended to be put (e.g., transporting equipment to a well site).

The containment means 2 includes a primary mixing tub 16 (as used herein, "tub" refers to and encompasses any container suitable for the use to which it is to be

put within the context of the overall invention). In a particular embodiment the tub 16 has a five barrel capacity or volume. Disposed in the tub 16 at an angle to the tub's vertical axis is a large agitator 18 by which high rolling action agitation and vibration can be imparted to the mixture in the tub to aid in wetting the cement within the mixture and in expelling air which can be entrained in the mixture. Referring to FIGS. 2 and 3 herein, the tub 16 is shown mounted on the vehicle 14. The mounting is by a suitable technique known in the art. As more clearly shown in FIG. 3, the tub 16 is mounted centrally between the two longitudinal sides of the vehicle 14 and adjacent two more mixing tubs 20, 22.

The two tubs 20, 22 define the preferred embodiment of the containment means 4 shown in FIGS. 1-3. Thus, the preferred embodiment of the present invention is a three mixing tub system; however, it is to be noted that various aspects of the present invention have utility with two-tub systems or systems with more than three tubs. The tubs 20, 22 of the preferred embodiment are conventional mixing containers. In a particularly preferred embodiment of the present invention, the tubs 20, 22 are implemented with conventional displacement tanks which are part of a conventional vehicle 14 (for example, the Halliburton Services trailer-mounted RCM.TM.-75TC4) used in performing cementing jobs at well sites. Such displacement tanks have heretofore been used to hold displacement fluid which is pumped behind a column of cement slurry to push the cement slurry to a desired location in the well bore. The displacement tanks are such that accurate determinations of the volume of displacement fluid pumped behind the cement slurry are obtained for maintaining proper

control of the placement of the slurry within the well bore. Using such displacement tanks also as mixing containers allows the vehicle 14 to be modified to implement the present invention and yet stay within the weight limitation of such vehicle 14.

In the specific implementation where the present invention is used to produce a cement slurry at a well site, each of the tubs 20, 22 might have a volume of ten barrels which individually provides adequate capacity and which in combination provides a twenty barrel capacity that is comparable to large capacity containers which have been used in prior systems used to produce cement slurries at well sites. As represented in FIG. 1, large agitators 24, 25, can be disposed in the tubs 20, 22 respectively for providing agitation to the bodies of mixture contained in the respective tubs. As best shown in FIG. 3, the tubs 20, 22 are disposed adjacent each other across the width of the vehicle 14 and also adjacent the centrally located tub 16.

The mixtures which are produced in the tubs 16, 20, 22 result from the initial mixtures which are produced and input by the inlet means 6. In the illustrated preferred embodiment, the inlet means 6 includes flow mixing means 26 for receiving and mixing a first substance and a second substance and for outputting a mixture which includes the first and second substances. In the preferred embodiment the flow mixing means 26 includes a cement inlet 28 for receiving dry cement, a water inlet 30 for receiving water, and a mixture output 32 for outputting a cement slurry of received cement and water into the primary mixing tub 16. This is particularly implemented in the preferred embodiment by an axial flow mixer connected to the tub 16. The axial flow mixer comprises the aforementioned inlets and outlet and further comprises one, and only

one, valve through which the water is admitted into the mixture and then into the tub 16. The axial flow mixer has dual recirculating inlets 34, 36 and constant velocity water jets (not shown). The cement inlet 28 of the flow mixer 26 is connected to means for selectably admitting the dry cement into the flow mixer 26. This includes a bulk cement metering device 38, such as a valve of a type known in the art (for example, a conventional bulk control cement head valve). The metering device 38 is shown connected to a bulk surge tank 40 into which dry cement is loaded in a conventional manner. A valve 39 can be included for a purpose described hereinbelow.

The water inlet 30 of the flow mixer 26 is connected to a source of water such as is provided through a conventional pump 42 and a conventional valve 44. As the flow mixer 26 receives cement and water and initially mixes it and provides it through its output 32 into the tub 16, the tub 16 fills to its capacity. Further input to the tub 16 from the flow mixer 26 causes an overflow from the tub 16. This overflow is communicated over one or more weirs into either or both of the tubs 20, 22. Weirs 46, 48 are illustrated in FIG. 3 and produce the flows 50, 52, respectively, schematically illustrated in FIG. 1. These weirs 46, 48 define in the preferred embodiment the means 8 for selectably directing a portion of the mixture from the tub 16 into the tubs 20, 22. These direct the overflowed averaged mixture from the tub 16 into either or both of the tubs 20, 22 for final mixing, averaging of the mixture density and improving of the distribution of any additives within the final mixture. The means 8 can be constructed so that the overflow from the tub 16 is provided in series first to one of the tubs 20, 22 and then to the other. In this way, one of the tubs 20, 22 can be used to produce a lead cement slurry, and the

other of the tubs 20, 22 can be used at a later time to produce a tail cement slurry. Alternatively, the tubs 20, 22 can be used in parallel by overflowing from the tub 16 simultaneously into both of the tubs 20, 22. The means 8 could include something other than weirs, such as a pump for pumping contents of the tub 16 to the tubs 20,22. When the tubs 20, 22 are displacements tanks, it is apparent that use of them in the foregoing manner gives them a dual function in that they are used not only as displacement tanks, but also as averaging tubs in which final cement slurries are produced from the mixture passed into them from the primary mixing tub 16.

To produce the desired densities in the mixtures of the tubs 20, 22 in the manner of the preferred embodiment of the present invention, the recirculation means 10 is used. The recirculation means 10 includes a recirculation subsystem 54 for recirculating at least a portion of the first averaged mixture from the tub 16 to the recirculation inlets 34, 36 of the flow mixer 26 of the inlet means 6. The recirculation means 10 also includes a recirculation subsystem 56 for recirculating at least a portion of the second averaged mixture from the selected one or both of the tubs 20, 22 to the recirculation inlets 34, 36 of the flow mixer 26 of the inlet means 6.

The subsystem 54 includes a pump 58 (for example, a 6.times.5 centrifugal pump) having an inlet connected to the mixing tub 16 and having an outlet connected to the flow mixer 26. These connections are made through suitable conduit means 60. The subsystem 54 of the preferred embodiment has a recirculation rate two to three times that of a previously conventional system (for example, 25 barrels per minute versus 8-

10 barrels per minute). This improves mixing and energy, and it improves control measurement.

The recirculation subsystem 56 includes a pump 62 (for example, a 6.times.5 centrifugal pump). The pump 62 has an inlet connected to at least the two secondary mixing tubs 20, 22. As illustrated in FIG. 1, the inlet is also manifolded to the mixing tub 16 so that the slurry within the first averaged mixture can go directly from the tub 16 to high pressure pumps (not shown) supplied or boosted by the pump 62, to whose outlet the downstream pumps are connected as indicated in FIG. 1. The outlet of the pump 62 is also connected to the flow mixer 26. The connections of the pump 62 to the respective tubs and the flow mixer are made through suitable conduit means 64. Shown disposed in the conduit means 64 are conventional valves 66, 68, 70, 72, 74 and a conventional control orifice 76 (for example, a Red Valve pinch valve). As is apparent from FIG. 1, the flow from the pump 62 is split between the downhole, or out-of-the-apparatus, stream and the recirculation stream when the valves 72, 74 are both open. Thus, the recirculation flow rate equals the difference between the pump rate of the pump 62 and the flow rate downhole through the valve 72. The recirculation provided by the subsystem 56 increases the mixing energy available within the flow mixer 26 above that which would be provided by the subsystem 54 alone.

Reference will now be made to the control means 12. In the preferred embodiment, the control means 12 responds to a desired density for the second averaged mixture to be obtained from one or both of the tubs 20, 22 and to measured densities of both the portion of the first averaged mixture recirculated through the

subsystem 54 and the portion of the second averaged mixture recirculated through the subsystem 56. In response, the control means 12 controls the first and second substances received and mixed by the flow mixer 26 so that the second averaged mixture has the desired density.

Referring to FIG. 1, the control means 12 includes density measuring means 78, connected to the pump 58, for measuring density of the mixture pumped by the pump 58 during recirculation. The means 78 produces a signal in response to the density of the first averaged mixture recirculated through the pump 58. In the preferred embodiment the means 78 is implemented by a six-inch densimeter of a type as known in the art (for example, a Halliburton Services radioactive densometer). The densimeter is disposed in the conduit 60 in the embodiment shown in FIG. 1.

The control means 12 also includes density measuring means 80, connected to the pump 62, for measuring density of the cement slurry pumped by the pump 62. The means 80 produces a signal in response to density of the second averaged mixture recirculated through the pump 62. The means 80 in the preferred embodiment includes a conventional densimeter (for example, a Halliburton Services radioactive densometer) disposed in the conduit 64 between the outlet of the pump 62 and a junction 82 where the downhole and recirculation flows split.

The control means 12 further comprises means for entering system design parameters, control tuning factors and job input parameters, including the desired density for the second averaged mixture. Another one of the entered parameters is a desired rate at which the second averaged mixture is to be pumped into the well. The

other system parameters and factors are shown in FIG. 4A, which will be further discussed hereinbelow. In the preferred embodiment, the parameter entering means is implemented by a conventional data entry terminal 84 (for example, the keypad of a Halliburton Services UNIPRO II), which interfaces in a known manner to a suitable programmed computer 86 forming another part of the control means 12.

The computer 86 of the preferred embodiment is a digital computer (for example, as is in the Halliburton Services UNIPRO II) which is connected to the densimeters 78, 80 by electrical conductors 88, 90, respectively. The computer 86 is also connected to the data entry terminal 84 by electrical conductor(s) 92. The computer 86 is responsive to electrical signals received over these conductors so that, as programmed, the computer 86 includes means for providing respective control signals over electrical conductors 94, 96 to the valve 38 of the dry cement inlet path and to the water inlet valve of the flow mixer 26. As illustrated in FIG. 1, the computer 86 is also responsive to pressure measured in the dry cement inlet flow by a conventional pressure sensor 98 (for example, a Datamate 0-50 psig pressure transducer). The signal generated by the sensor 98 as a measure of the pressure of the inlet substance is communicated to the computer 86 over one or more electrical conductors 100. In an alternative preferred embodiment, the inlet pressure can be maintained constant, such as by means of the control valve 39 (FIG. 1), so that varying pressure is not a factor in such an embodiment thereby obviating the need for the sensor 98. The valve 39 could typically be a conventional pressure reducing valve for maintaining downstream pressure constant while upstream pressure varies.

The means provided by the programmed computer 86 more particularly comprises means for performing initial calculations in response to system design parameters, control tuning factors and job design parameters entered through the data entry terminal 84. The means provided by the programmed computer 86 further comprises means for generating, in response to entered system design parameters, control tuning factors and job design parameters and in response to initial calculations and measured densities, a control signal for a first one of the substances passed through the inlet means 6 and a control signal for a second one of the substances passed through the inlet means 6. In the illustrated preferred embodiment, this includes means for computing a calculated density error and for generating the control signals in response to the calculated density error. More particularly, there is a means for generating on signal to control the valve 38 by which the dry cement is selectably admitted to the flow mixer 26, and a means for generating one signal to control the valve of the flow mixer 26 through a conventional valve plate position control device 102 (for example, a proportional positioner, such as the Vickers XPERT DCL, a compact electrohydraulic package for digital control of linear drives).

The foregoing means of the programmed computer 86 are implemented by the programming and operation indicated in the flow charts of FIGS. 4 and 5. The first two boxes of the flow chart in FIG. 4A identify and describe the self-explanatory system design parameters, control tuning factors and job input parameters which are entered through the data entry terminal 84. The values for CTDNMX and CTDNMN are selected based on operator knowledge. The next box of FIG. 4A and the first box in FIG. 4B

contain the equations for the initial calculations performed within the programmed computer 86. The first six listed equations are specific to each slurry design. The first three equations shown in FIG. 4B are proportional, integral and differential factors, respectively. In the illustrated preferred embodiment, the proportional factor PARP12 decreases in response to increasing the entered rate SLR; the integral factor PARI13 increases in response to increasing SLR; and the differential factor PARD14 decreases in response to increasing SLR. These relationships and the specific values shown in FIG. 4B were empirically derived from computer simulations and are not limiting of the present invention. That is, the present invention in its broader aspects is not limited to particular computational factors or processes.

From the initial calculations and entered factors and parameters, along with the measured parameters sampled at an interval defined as TSAMP indicated in the fourth box of FIG. 4 (i.e., DENRS, DENRSF, and PTNK listed in FIG. 4B; the WTRATE signal is not implemented or used in the subsequent calculations, but it can be provided as a verification feedback signal), the production of the cement slurry is controlled using the formulas identified in the second box of FIG. 4B. Of particular importance is the base equation defining the calculated density error DELDN. This is listed as equation (3) in FIG. 4B. This is the initial equation shown in the flow chart of FIG. 5 which shows the methodology by which the equations listed in FIG. 4B are implemented. The parenthetical numbers shown within the boxes of FIG. 5 correspond to the numbered equations in FIG. 4B.

As shown in FIG. 5, the calculated density error, DELDN, uses the density measurements from both densimeters 78, 80 (DENRS, DENRSF, respectively). From equation (3) in FIG. 4B, DELDN also uses: the entered desired mix density, DENSN; the entered volumes, TUBV and TUBV2, of the primary and secondary mixing tubs; the entered total secondary mixing tub recirculating pump rate, RRP2, of the pump 62; and the entered slurry mix rate, or rate at which the slurry is to be pumped out of the apparatus, SLR (stated another way, RRP2-SLR is the net amount recirculated from the secondary tub and RRP2 is the net flow from the primary tub to the secondary averaging/mixing tub when there is continuous full circulation through the system). These are arithmetically combined to define DELDN as: DENSN-DENRS+(DENSN-DENRSF)*(TUBV2/TUBV)*(RRP2-SLR)/RRP2=[difference between the desired density and the measured density of recirculated flow through the subsystem 54]+[difference between the desired density and the measured density of recirculated flow through the subsystem 56, adjusted by the ratio of the secondary tub volume to the primary tub volume and by the proportion recirculated by the pump 62].

The cement error, CMTER, is calculated from the calculated density error. The cement error is then processed through proportional, integral, differential (PID) error computations of known type but utilizing in the preferred embodiment the aforementioned proportional, integral and differential factors (PARP12, PARI13, PARD14). The differential error computation is also a function (specifically, a hyperbolic function in the preferred embodiment) of the absolute value of the calculated density error, DELDN, as shown in FIG. 4B by the two unnumbered equations between

equations (10) and (11). This is implemented by the portion 104 of the flow chart shown in FIG. 5. The cement correction factor, CNCMRA, produced from the PID function 104 is added to the desired cement rate, CMDN, from the "initial calculations" to produce the corrected desired cement rate, CMTDT. This value is processed through the remainder of the functions illustrated in FIG. 5 to produce the cement valve position control signal, CMVLPO, and the water valve position control signal, WTRAT. These two signals produce an overdriving or underdriving of the initial mixtures through the flow mixer 26 to obtain more rapidly the desired density in the second averaged mixture of the secondary tubs 20, 22. To prevent such overdriving or underdriving from being too severe, whereby inadequate mixing of the cement and water might result, limits are placed through the bounding function of equation (16) (FIG. 4B). The bounding is set with the entry of CTDNMX and CTDNMN, the valves of which are selected by the operator from his or her experience.

Although the CMVLPO and WTRAT signals are the control signals by which the computer 86 controls the inlet means 6, the computer 86 also is programmed in the preferred embodiment to compute the value NDENS identified as equation (21) in FIG. 4B. This value is the calculated theoretical density of the initial mixture provided by the flow mixer 26. That is, it is the calculated result which should be obtained from the application of the CMVLPO and WTRAT control signals to the valve 38 and the valve of the flow mixer 26, respectively.

The various parameters and factors can be changed according to particular usages. For example, control gain factors would need to be changed between using the

secondary tubs alternately and in parallel. The system could be designed to provide a signal indicating the type of operation, from which signal the computer could implement the needed parameter/factor change. As another example, the PID values of PAR12, PAR13 and PAR14 could be made variable rather than fixed. The variation could be a function of DELDN, SLR or other value. Such a change would preferably be implemented to obtain the best system performance.

From the graphs of FIGS. 6 and 7 it can be seen that the system of the present invention, utilizing both recirculation lines in combination with respective densimeters (curves 110, 116) drives the contents of the primary tub to a much higher density to average out with the contents of the secondary tub, thereby providing means for achieving faster secondary tub response. Significant features of the present invention include the use of a second recirculation line and a second densimeter, particularly when applied in the calculated density error, DELDN. Maximum and minimum mix density values which are inputted to bound the overdriving or underdriving allows the system to make faster corrections without exceeding the ability of the system to mix at the correction density values. The present invention also operates in accordance with the foregoing to maintain a constant mix rate even though corrections are being made. This is achieved by controlling both, rather than only one of, the dry cement and water inlet flows For the embodiment shown in FIG. 1, the system also controls in response to the bulk cement delivery pressure to allow corrections of the cement valve delivery factor to be made on the fly. Over a given tank delivery, the bulk delivery pressure typically declines significantly and actual delivery of the bulk substance declines

commensurately. Thus, the calibration factor of the cement valve needs to be continually corrected. As previously mentioned, this can be obviated if constant pressure is maintained in the delivery system.

From the foregoing, it is apparent that the present invention includes means for controlling the inlet means 6 in response to the calculated density error, DELDN. The control means also includes means for overdriving or underdriving the flow mixing means 26 to produce in the first averaged mixture within the tub 16 excess or deficient density which is within a range between a predetermined maximum density, CTDNMX, and a predetermined minimum density, CTDNMN. The control means also controls the first substance and the second substance so that the flow mixing means 26 outputs the mixture at a constant rate.

The foregoing preferred embodiment of the apparatus of the present invention can be used to implement the method of the present invention by which the production of the mixture is controlled so that the mixture has a desired density. The mixture includes at least two substances passed through a flow mixer into a first tub and from the first tub into a second tub where the mixture is defined. Correlating this to the illustrated embodiment, the method comprises the steps of recirculating contents of the tub 16 to the flow mixer 26; recirculating contents of one or both of the tubs 20, 22 to the flow mixer 26; measuring with the densimeter 78 the density of the recirculated contents of the tub 16; measuring with the densimeter 80 the density of recirculated contents of the tub(s) 20, 22; controlling the introduction of water into the flow mixer 26 in response to the desired density and both of the measured densities; and controlling the

introduction of dry cement into the flow mixer 26 in response to the desired density and both of the measured densities. For the illustrated embodiment shown in FIG. 1, which incorporates the pressure sensor 98 for measuring pressure of the dry cement prior to it passing into the flow mixer 26, the step of controlling the introduction of the dry cement into the flow mixer 26 is also responsive to the measured pressure.

Preferably, the steps of controlling the introduction of the two substances are performed to control them relative to each other so that a constant mix rate is maintained. It is also preferred that these two steps be performed to control the introduction of the substances relative to each other so that the density of a mixture from the flow mixer is within a range between a predetermined maximum density value and a predetermined minimum density value.

In accordance with the preferred embodiment apparatus, the corresponding preferred method includes, within the step of recirculating contents of the tub(s) 20, 22, pumping contents of the tub(s) 20, 22 with a pump at a known pump rate, RRP2. The steps of measuring density respectively include: producing a signal, DENRS, in response to density of recirculated contents of the tub 16; and producing a signal, DENRSF, in response to density of recirculated contents of the tub(s) 20, 22. The preferred method further comprises performing the two controlling steps concurrently, including: entering the desired density, DENSN, into the digital computer 86; entering into the digital computer 86 a desired rate, SLR, at which the mixture is to be pumped from the tub(s) 20, 22 for use other than being recirculated; computing in the digital computer 86 a calculated density error, DELDN, wherein: DELDN=DENSN-

DENRS+(DENSN-DENRSF)* (TUBV2/TUBV)*(RRP2-SLR)/RRP2, where TUBV is the volume of the tub 16 and TUBV2 is the volume of the tub(s) 20, 22; and generating with the digital computer 86, in response to the calculated density error, control signals for controlling the introduction of the water and dry cement into the flow mixer 26.

A more particular embodiment of the method of the present invention is one for performing a cement job on a well so that a cement slurry is made and placed in the well using conventional displacement tanks for the dual purposes of being secondary mixing containers and subsequently conventional displacement tanks. This method includes flowing cement and water through a mixer into a tub to provide a mixture constituting a first body of cement slurry. As previously described, this is implemented in the illustrated apparatus by controlling both the valve 38 through which the cement flows and the valve of the flow mixer 26 through which the water flows into the mixer. This occurs in response to measured densities of the recirculated portions of the first body of cement slurry and a second body of cement slurry created by flowing a portion of the first body of cement slurry into a displacement tank.

As illustrated in FIGS. 1-3, for the preferred embodiment apparatus, the creation of the first body of mixture occurs by flowing dry cement through the valve 38 into the flow mixer 26 which is connected to the tub 16 mounted on the vehicle 14 located at a well (not shown). Water is flowed through the valve in the flow mixer 26. These flows are controlled by controlling the respective valves in response to measured densities of the recirculated mixtures.

To form the cement slurry in the displacement tank(s) 20, 22, at least part of the collected mixture from the tub 26 is flowed into at least one of two displacement tanks 20, 22 mounted on the vehicle 14 so that cement slurry is in at least one of the displacement tanks. Cement slurry from the displacement tank or tanks is flowed into the well. This is done by pumping initially with the pump 62 for the embodiment of the apparatus shown in FIG. 1 and subsequently by pumping with downstream high pressure pumps of types known in the art (not shown).

Once slurry has been removed from a displacement tank, displacement fluid is flowed into the displacement tank and the displacement fluid is thereafter flowed, using the pump 62 and the high pressure pumps, from the displacement tank into the well behind the cement slurry to place the cement slurry at a desired location in the well. If the displacement fluid is chemically reactive with the cement slurry, the displacement tank is first washed before it is filled with the displacement fluid. An example of how the displacement tank can be washed includes using a rotating nozzle of an automatic wash system which jets water along the inner surface of the displacement tank. The dirty wash water can be pumped by the pump 62 through the recirculation circuit 56 back into the flow mixer 26 and the tub 16 as part of the water added to the mixture which is continuing to be made.

When at least two displacement tanks are used, as illustrated in FIGS. 1-3, one displacement tank can be washed and used in its conventional manner while the other displacement tank is being used as the secondary averaging tub. If washing is needed, the method includes washing the displacement tank with washing water; flowing the

washing water from the displacement tank for combining the washing water with cement and water flowing through the mixer 26 into the tub 16 to add to the first body of cement slurry or mixture within the tub 16; flowing a portion of the added-to first body of cement into the other displacement tank to provide another body of cement slurry; flowing this other body of cement slurry from the other displacement tank into the well; washing with more washing water the other displacement tank from which the other body of cement slurry was flowed and flowing such more washing water into the tub 16; and flowing displacement fluid into this washed displacement tank. Both tanks can then be used in their conventional manners for flowing displacement fluid into the well. The wash water returned from the other, second displacement tank can be pumped into the tub 16 using the pump 62 and held in the tub 16 since no further mixing is likely to occur for that particular job. The displacement tanks are then both available for holding displacement fluid which is to be pumped behind the cement slurry which has been completely pumped from the apparatus of the present invention.

Accordingly, **Allen (US 5,114,239)** discloses a sensor 78 in the recirculation line 60 for measuring a parameter of the mixture and a sensor 80 in the discharge flow line 82 for measuring a parameter of the mixture but does not disclose the sensors being water concentration sensors.

DE 1921681 discloses a system for preparing a mixture of water and at least one non-aqueous material, comprising: a mixing zone 6; means 4, 8 for injecting water into the mixing zone; means for injecting the at least one non-aqueous material into the mixing zone (the inclined feed conveyor means seen on the right side of the Figure);

and a sensor 1 disposed within the mixing zone that measures the concentration of water in the mixture; wherein the mixing zone comprises a mixing tub 6; wherein the sensor 1 is disposed within the mixing tub as seen in the Figure. It would have been obvious to one having ordinary skill in the art, at the time applicant's invention was made, to have substituted the sensors in Allen '239 with water concentration sensors as taught by DE 1921681 for the purposes of measuring and controlling the water content of the mixture during production without interrupting the mixing process (see the translation, page 1, lines 2-4); for measuring, controlling and recording the actual water content of the mixture with great accuracy and in an economic manner (page 3, lines 19-22); for using the measured values of water content to trigger processes for controlling water dosing to the mixture (page 4, lines 8-22); and for ensuring quality of the mixture and providing a record of the quality of the mixture (page 5, lines 17 through page 6, line 3).

Wang et al. (US 6,169,407) discloses a processing system for blending multiple materials used in many different applications (col. 3, lines 11-25) having a mixing zone 10, 156 (see the mixer in Figs. 7-10 that feeds a mixture to the inlet of system 10 labeled "FROM MIXER" in Figure 1 and wherein the mixer is fed a mixture from the system 10 labeled "TO MIXER in Figure 1); means for injecting a material such as water into the mixing zone (col. 4, lines 32-41); means for injecting the other material into the mixing zone (col. 4, lines 32-41); and a water sensor 20 disposed within the mixing zone that measures the concentration of water in the mixture (col. 3, lines 36-47). Alternately, it would have been obvious to one having ordinary skill in the art, at the time

applicant's invention was made, to have substituted the sensors in Allen '239 with water concentration sensors as taught by Wang et al. (US 6,169,407) for the purposes of providing a water metering apparatus comprising an improved sensor which produces a substantially linear output for a wide range of water concentrations in a mixture (col. 2, lines 23-28); for adjusting the water level in the mixture (col. 4, lines 33-41); and to provide a consistently blended mixture (col. 7, lines 38-42). Wang et al. also teaches that the water concentration sensor can be located at various locations in the processing system, including a recirculation circuit (col. 3, lines 40-53).

Response to Amendment

11. Applicant's arguments with respect to the pending claims have been considered but are deemed to be moot in view of the new grounds of rejection necessitated by amendment.

Applicant requests a translation of DE 1921681, however, such a translation was provided to the PTO with the Applicant's own IDS of 19 AUG 2005, a copy of the initialed IDS being attached to the last office action. Since the rejection was not addressed, the rejection is repeated for Applicant's consideration. As a courtesy to Applicant, an exact copy of DE 1921681 <u>and</u> the translation filed by Applicant in the IDS of 19 AUG 2005 (and relied upon in this rejection) is listed on the attached PTO-892 form and attached to this office action.

A new 103 rejection is also proffered for Applicant's consideration to address Applicant's concerns in the last response. DE 1921681 and Wang et al. (US 6,169,407)

clearly teach and provide ample motivation for the use of water concentration sensors for sensing the concentration of water in a mixture and the combination of these either of these references with Allen '239 is considered prima facie obvious for the reasons advanced in section (10) above.

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Charles E. Cooley whose telephone number is (571) 272-1139. The examiner can normally be reached on Mon-Fri. The examiner's supervisor, Wanda Walker can be reached on (571) 272-1151. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Charles E. Cooley
Primary Examiner
Art Unit 1723

12 January 2007